Radioactive Decay

Purpose: This lab on radioactive decay is one done by using a large number of pennies (100 - 200 or more if you have them).

Materials: You need to start with a large number of pennies (100 - 200 or more if you have them).

Procedures:

Step 1. Place all pennies in a flat box (one with a cover) so that all are tails up. Cover the box and shake thoroughly.

Step 2. Remove all the pennies that are now heads up. Record this number on a chart. These represent the atoms that have decayed through one $t_{1/2}$. On your chart record the number remaining in the box as well.

Step 3. Continue to follow step 2 until all the pennies are removed from the box. Make certain you record the number of trials needed to complete the process. Each trial is one shaking of the box and removal of the heads up items.

Step 4. On graph paper make the following plot: Place the number of trials (l.x) on the horizontal axis equally spaced apart. On the vertical axis place the number of pennies used (1...100) equally scaled apart. Plot the number of decayed atoms using a triangle as the point protector (plot the accumulated number of heads up coins removed; i.e., this number will increase as long as coins are removed from the box) and plot the number of atoms that did not decay (remained in the box) per trial using a circle point protector.

Step 5. Make certain your graph contains all the needed titles, axis labels, etc.

Part 2:

Radioactive Decay In this lab you will investigate radioactive decay by using pennies to simulate decaying nuclei. In this lab, a penny will decay when it comes up heads (although you might not have known that this happened to pennies). You will investigate the half-life of pennies and you will take a look at probability with regard to small numbers and large numbers. The difference is important. When you throw 8 pennies, you would expect 4 pennies to come up heads the most often, but sometimes-different numbers of heads will occur. You would actually be surprised if 4 pennies came up heads every time.

Procedure:

1. You will throw 8 pennies for each decay cycle. A decay cycle for this lab will be until you have 1 or 0 pennies left. You will do 50 of these decay cycles. This sound like a lot but each cycle can be done in much less than a minute even when taking the required data Set up a data table to do this quickly. A sample follows.

TRIAL NUMBER	# DECAYED 1ST TIME	# OF.THROWS to get 1 or 0

2. For each trial, record the number of heads that shows up on the first throw. Also record the number of throws that is required to have one or no pennies left.

Analysis:

1. Find the total number of pennies that `decayed' on the first throw by adding the "Number Decayed 1st Time."

2. The total number of pennies you threw on the first throw is 50 trials times 8 pennies each trial. Find the percent of the total number of pennies thrown which 'decayed" the first time.

3. Draw a bar graph of the number of pennies, which decay, on the first throw showing the number of trials where a given number of pennies "decayed." (If 2 decayed on the first throw 6 times, draw a bar up from the horizontal axis 6 units at the 2 positions.)

4. Find the average number of throws required for 1 or 0 pennies to be left. This is the average value of three half-lives.

5. Draw a bar graph of the number of throws needed to get 1 or 0 pennies showing the number of trials when it took a given number of throws. (If twice it took 7 times to have only 1 or 0 left, then draw a bar 2 units long at 7.)

Conclusions:

1. Is the total number of pennies that decayed on the first throw expected? Theoretically 50% would decay each throw; did this happen?

2. Comment on whether the expected number of heads came up on the first throw on a particular trial. Choose a trial at random, say trial 34, and see if the expected number of heads showed up. Did you expect this?

3. Comment on whether the first half-life of the pennies is expected. One would expect half the pennies to decay on the first throw; did this happen?

4. Is the time for three half-lives expected?

5. Discuss error, if any, in this lab.

6. In radioactive decay, you do not know which particular atom is going to decay. And did you known that a certain percentage is going to decay in a given amount of time. Does this lab show this kind of decay?